In Claims **7 and 33,** the Examiner opines that the limitation " the diacrylate ester of an alkanolglycidyl ether is 1,4-butanedioldiglycidyl ether and diacrylate ester of an ethoxylated aromatic epoxide" is unclear since it appears that the diacrylate is two different compounds. The Examiner also points out that "ethoxylated" is misspelled. In response, Claims 7 and 33 have been amended by replacing the word "and" with -or- and the word "of" with -is-. The amended claim language clarifies that Claims 7 and 33 simply recite the type of acrylates preferred by Applicants. More specifically, these are the diacrylate esters of the functional groups recited in Claim 6. As recited in Amended Claims 7 and 33, these are the diacrylate esters of alkanolglycidyl ethers, namely the diacrylate ester of a 1,4-butanedioldiglycidyl ether **or** the diacrylate ester of an ethoxylated aromatic epoxide. Basis for the amendment is found on page 5, lines 13-19, of Applicants' specification. Also, the mis-spelling of "ethoxylated" has been corrected in Claims 7 and 33 and where ever it appeared in the specification. The rejection can now be withdrawn.

In Claims **8 and 34,** the Examiner opines that there is no basis in the claim to ascertain whether the limitation "the ethoxylated aromatic epoxide contains 6 to 20 ethoxy groups" pertains to 6 to 20 ethoxy groups per repeat unit or per mole. In response, Applicants fail to see why the Examiner is unclear as to the basis for the

ethoxylated aromatic epoxide containing 6 to 20 ethoxy groups (i.e. whether such ethoxylation is per repeat unit or per mole, etc.). The ethoxylated aromatic epoxide forms part of Applicants' water soluble oligomer compound which in turn contains:

> "two or more terminal, or pendent, alpha, beta-ethylenically unsaturated **groups** which are linked through polymeric backbone, or through similar linking **groups** to a central aliphatic or aromatic backbone (see page 5, lines 5 to 9 of Applicants' specification).

As can be seen, the structure of Applicants' oligomer is defined in terms of **groups**. Therefore, a reasonable interpretation would be that the basis for the 6 to 20 ethoxy groups is per repeat unit of the epoxide group. Moreover, page 5, line 19, of Applicants' specification states "the ethoxylated aromatic epoxide contains 6 to 20 ethoxy **groups**." Applicants' epoxides are not described in molar proportions but is described as part of a group linked to a polymeric backbone. It follows that any degree of epoxide ethxoylation would likewise be on a per unit or group basis. Applicants' request clarification of the rejection in view of the foregoing or strongly urge that the rejection be withdrawn.

In Claims **9 and 35,** the Examiner opines that there is no basis in the claim to ascertain whether the limitation "wherein water is present in an amount ranging from 5 weight % to about 25 weight %" is based on the weight of the total composition or the weight of the acrylate and water, etc. In response, Claims 9 and 35 have been amended by adding the language "based on the weight of the aqueous composition." Basis for the amendment can be found in Examples 3 to 6 of Applicants' specification. The rejection can now be withdrawn.

In Claim **16,** the Examiner opines that there is no antecedent basis for the limitation "the substrate". In response, Claim 16 and 17 have been amended such that "substrate" now reads -surface-. The antecedent basis for the "surface" element appears in Claim 1. The rejection as to Claim 16 can now be withdrawn.

The Invention

First, the invention is an improved actinic radiation curable aqueous single fluid composition having a water soluble compound containing (a) at least one alpha, beta-ethylenically unsaturated, radiation polymerizable group and (b) water; wherein the improvement is when a surface is coated with the composition and exposed **once** to actinic radiation in the presence of the water, a

cured film is formed, wherein **less than 50 ppb of uncured residue is extractable therefrom** when the film is immersed and heated in 10 ml of a simulant liquid per square inch of cured film.

Secondly, the invention is also a **method for producing a low-extractable film** comprising the steps of:

(a) providing an actinic radiation curable aqueous single fluid composition having a water soluble compound containing (a) at least one alpha, beta-ethylenically unsaturated, radiation polymerizable group and (b) water;

(b) applying said aqueous composition onto a surface; and

(c) irradiating the surface **in a single step** with actinic radiation in the presence of the water;

thereby forming a cured film is formed wherein **less than 50 ppb of uncured residue is extractable therefrom** when the film is immersed and heated in 10 ml of a simulant liquid per square inch of cured film.

(10) Rejection Pursuant to 35 U.S.C. § 102

Claims **1-19, 27-42, 44 and 48** have been rejected under 35 U.S.C. 102(e) as being anticipated by Stevenson et al. (US Patent 6,087,417). Stevenson et al. disclose an aqueous, solvent-free, curable coating composition and a method of forming cured coated substrates with same. Stevenson et al. form their composition by

blending the reaction product of an epoxy resin, a monocarboxylic acid and a tertiary amine, referred to as **(A)**, with a reactive diluent and optionally a curing agent. The composition can also contain up to 70 wt. % water (see Col. 4, line 64).

Applicants' point out that **(A)** is formed in several steps. The first step, **(A1)**, involves reacting a resin (e.g. epoxy resin) containing oxirane functionalities with a molar deficient or molar excess amount of a monocarboxylic acid, having at least 50 mole % α, β - ethylenicaly unsaturation. The acid converts the oxirane groups of the resin to ester groups. However, the molar conversion must be no more than 75 mole %. Once the desired fraction of oxirane groups are esterified, additional tertiary amine and carboxylic acid is added in a second step **(A2)**, to quaternize the **remaining oxirane groups**. Alternatively, (A1) and (A2) can be carried out in a single step, provided the oxirane to acid ratio is controlled so as to maintain the molar conversion of the oxirane to below 75 mole % (see Col. 4, lines 26 to 28). In a preferred embodiment, some or all of the mono carboxylic acid used in **(A2)** (e.g. alpha, beta-ethylenicaly unsaturated acid) is **pre-polymerized** with monomers such as styrene or the esters of acrylic or methacrylic acid (see Col. 3, lines 64 to 67 and Col. 4, lines 57). The pre-polymerization entails exposing the composition to heat, ultraviolet or electron beam radiation (see Col. 10, lines 52 to 62). Subsequent to the pre-polymerizing step, the pre-polymerized composition is heated to

completely cure (i.e. polymerize any unsaturated or acrylate, groups) the composition and ensure adequate adhesion to the substrate (see Col. 10, lines 63 to 65 and Col. 11, lines 5 to 15).

Stevenson et al. do not anticipate Applicants' invention as it fails to disclose a number of essential elements and/or features of Applicants' invention. For instance, Stevenson et al. require that the molar conversion of oxirane (contained in the resin) be no more than 75 mole %. Therefore, their curable aqueous composition would unavoidably contain substantial amounts of oxirane. Oxirane is not curable by actinic radiation but is curable (i.e. opening of the epoxy ring thereby making the oxygen available for bonding) by heating or applying some type of thermal source. Pre-polymerization in Stevenson et al. is merely aimed at curing converted oxirane while the unconverted oxirane functionalities the portion of the compound, remain only to be later cured in a subsequent heating step which to completely cures the composition. Therefore, Stevenson et al.'s **aqueous composition is not completely curable (or polymerizable) by exposing in a single step to actinic radiation.** Applicants, on the other hand, claim an aqueous composition that, when exposed to actinic radiation, is completely curable (or completely polymerizable) in a single step – i.e. **no pre-polymerization and subsequent heating is required.**

Secondly, since Stevenson et al. require that the molar conversion of oxirane be limited to 75 mole %, their aqueous

composition, even upon being completely cured, would not form a cured film in compliance with standard government regulations (e.g. US FDA Regulations) for food and beverage packaging (i.e. a film wherein "**less than 50 ppb of uncured residue is extractable therefrom when the film is immersed and heated in 10 ml of a simulant liquid per square inch of cured film**.". A physical attribute that is required if the film is to used for food and beverage packaging applications. Stevenson et al. make mention that their aqueous compositions are "especially suitable for food and beverage packaging". However, they fail to specify or even illustrate how. By contrast, Applicants provide data to support and illustrate their claim that aqueous composition once cured in a single step forms a film that is regulatory compliant with the standard food and beverage packaging regulations (see in particular pages 12 to 22 and Examples 8, 9, 10 and 11 of Applicants specification). In view of the foregoing, Applicants kindly ask that the rejection be withdrawn.

(12) Rejection Pursuant to 35 U.S.C. § 103

Claims **20, 22-26, 43, 45-47 and 49** have been rejected as being unpatentable over Stevenson et al. During the interview with the Office, Applicants and their attorney established that Applicants' method for producing a low-extractable film from an actinic radiation curable aqueous single fluid composition, wherein less than 50 ppb of uncured residue is extractable therefrom when the film is

immersed and heated in 10 ml of a simulant liquid per square inch of cured film, is not at all rendered obvious by Stevenson et al.

As for the particular rejection, the Examiner opines that Stevenson et al. teach Applicants' invention, despite, failing to specifically teach the use of polyolefin substrates only obvious variants of same. Notwithstanding the Examiner's views of the differences of type of substrate employed, Stevenson et al. do not teach or even suggest Applicants' invention. As previously discussed, Stevenson et al. require the molar conversion of the oxirane portion of the resin to be below 75 mole %. Therefore, their curable aqueous composition would unavoidably contain substantial amounts of oxirane which, as pointed out above, is not curable (i.e. opening of the epoxy ring thereby making the oxygen available for bonding) by actinic radiation. Thus, the pre-polymerization step in Stevenson et al. cures only the converted oxirane while unconverted oxirane goes uncured until a subsequent heating step which is required to completely cure the curable aqueous composition . Accordingly, Stevenson et al. does not teach or suggest Applicants' curable aqueous composition as it is **completely curable** (or polymerizable) upon exposure to actinic radiation in a single step without any need for a subsequent curing step.

As for the extractable contents and method of measuring same, the Examiner opines that it is well known to determine extractable amounts by utilizing standard protocols. The Examiner, therefore,

concludes that it would have been obvious for one skilled in the art to use a standard measuring protocol to determine the extractable amount, for health related reasons, for the food packaging material taught by Stevenson et al. It is important to note that Stevenson et al. require that the molar conversion of oxirane be no more than 75 mole %. Therefore, their curable aqueous composition, even when completely cured, would not necessarily have an extraction level for migratable components in compliance with standard government regulations (e.g. US FDA Regulations) for food and beverage packaging (i.e. a cured film wherein less than 50 ppb of uncured residue is extractable therefrom when the film is immersed and heated in 10 ml of a simulant liquid per square inch of cured film). This physical attribute is actual met by Applicants' curable aqueous composition. While, Stevenson et al. simple mention that their aqueous compositions are "especially suitable for food and beverage packaging" without any proof or illustration that they are regulatory compliant. By contrast, Applicants provide data to support and illustrate that films formed from their curable aqueous compositions are compliant with standard food and beverage packaging regulations (see in particular pages 12 to 22 and Examples 8, 9, 10 and 11 of Applicants specification). In view of the foregoing, Applicants kindly ask that the rejection be withdrawn.

Applicants believe that the amendments and remarks provided herein adequately and completely address the rejections raised by

the Examiner. Therefore, Applicants respectfully request allowance and issuance of the outstanding claims.

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification

The paragraph at **page 3, line 1-7**, has been amended as follows:

-- a water soluble compound which contains at least one α, β - ethylenically unsaturated, radiation polymerizable group; and water;
(b) applying said aqueous composition onto a surface; and
(c) irradiating the surface in a single step with actinic radiation in the presence of the water to form a cured film; wherein less than 50 ppb of uncured residue is extractable from the cured film when said film is immersed and heated in 10 ml of a simulant liquid per square inch of cured film. --

The paragraph at **page 3, line 8-16**, has been amended as follows:

--A further embodiment of this invention is an improved actinic radiation curable single fluid aqueous composition comprising a water soluble compound which contains at least one α, β - ethylenically unsaturated, radiation polymerizable group; and water; wherein the improvement comprises the requirement that when a

surface is coated with the composition and exposed once to actinic radiation in the presence of the water, a cured film is formed wherein less than 50 ppb of uncured residue is extractable from the cured film when immersed and heated in 10 ml of a simulant liquid per square inch of cured film. Preferably, the water soluble compound is a water soluble oligomer containing two or more acrylic groups.--

The paragraph at **page 3, line 17-24**, has been amended as follows:

--A still further embodiment of this invention is a packaging material comprising a substrate and a cured film adhered to the surface of the substrate, wherein: the cured film is derived by providing an aqueous composition consisting essentially of a water soluble oligomer containing two or more acrylic groups; and water and curing the aqueous composition in a single step by actinic radiation in the presence of water such that less than 50 ppb of oligomer residue is extractable from the cured film when it is immersed and heated in 10 ml of a simulant liquid per square inch of the cured film.--

The paragraph at **page 11, line 1-26**, has been amended as follows:

--a surface of a substrate and without any substantial removal of water, the applied aqueous composition is irradiated in a single step with high energy electrons or UV radiation in the presence of the water to form a cured film. The aqueous composition may be applied to the substrate surface as a uniform coating using any conventional coating technique. Thus the composition may be spin coated, bar coated, roller coated, curtain coated or may be applied by brushing, spraying, etc. Alternatively the aqueous composition may be applied imagewise to the substrate surface, for instance as a printing ink, using any conventional printing technique. Once the aqueous coating composition is applied to the substrate surface, it is immediately cured without any prior removal of the water, using either high energy electrons or UV radiation. Typically the high energy electrons have an energy between 50 and 200 kV electrons and preferably between 85 and 180 kV electrons and are typically produced by high energy electron device. The dosage of high energy electron ranges from about 2 to about 4 megarads (Mrads); and preferably from 2.7 to 3.5 Mrads. UV irradiation may be carried out using any conventional off-contact exposure device which emits within the spectral region from about 200 to about 420 nanometers. The water in the coated composition, even on non-absorbent surfaces, does not interfere with curing process, but rather promotes complete curing of the oligomer into a completely cured film or image with little or no extractable oligomer. Water is believed to be

removed concurrently with the curing process and/or subsequently during manipulation of the substrate. As used herein the term "cured film" is intended to include a continuous cured film composition as well as a discontinuous cured ink image composition. In either sense of the term, the cured film is adhered to a substrate and has an outer "cured surface" which defines the surface area used in the extraction protocols fully described hereinbelow.--

In the Claims

1. (Amended) A method for producing a low-extractable film comprising the steps of:

(a) providing an actinic radiation curable aqueous composition comprising (i) a water soluble compound which contains at least one α, β -ethylenically unsaturated, radiation polymerizable group and (ii) water;

(b) applying said aqueous composition onto a surface; and

(c) irradiating the surface in a single step with actinic radiation in the presence of the water; thereby forming a cured film wherein less than 50 ppb of uncured residue is extractable from the cured film when immersed and heated in 10 ml of a simulant liquid per square inch of cured film.

7. (Amended) The method of claim 6 wherein the diacrylate ester of an alkanolglycidyl ether is 1,4-butanedioldiglycidyl ether [and] or the diacrylate ester [of] is an [exthoylated] ethoxylated aromatic epoxide.

9. (Amended) The method of claim 8 wherein water is present in an amount ranging from about 5 weight % to about 25 weight %, based on the weight of the aqueous composition.

16. (Amended) The method of claim 1 wherein the [substrate] surface is selected from the group consisting of a polyolefin, a polyethylene terephthalate, a metalized polyethylene terephthalate, polycarbonate, cellulosic material, paper material, cardboard material, metal, glass, polystrene, polyvinylchloride, polynaphthelene terephthalate, polyacrylate and polyacrylic.

17. (Amended) The method of claim 16 wherein the [substrate] surface is a food packaging material.

27. (Amended) An improved actinic radiation curable aqueous single fluid composition comprising: a water soluble compound which contains (a) at least one α, β -ethylenically unsaturated, radiation polymerizable group and (b) water; wherein the improvement comprises that when a surface is coated with the composition and

exposed once to actinic radiation in the presence of the water, a cured film is formed wherein less than 50 ppb of uncured residue is extractable therefrom when immersed and heated in 10 ml of a simulant liquid per square inch of cured film.

33. (Amended) The composition of claim 32 wherein the diacrylate ester of an alkanolglycidyl ether is 1,4-butanedioldiglycidyl ether [and] or the diacrylate ester [of] is an [exthoxylated] ethoxylated aromatic epoxide.

35. (Amended) The composition of claim 27 wherein water is present in an amount ranging from about 5 weight % and about 25 weight %, based on the weight of the aqueous composition.

48. (Amended) A packaging material comprising a substrate and a cured film adhered to the substrate surface derived by providing an aqueous composition consisting essentially of (a) a water soluble oligomer containing two or more acrylic groups and (b) water; applying the aqueous composition on the substrate; and curing in a single step by actinic radiation in the presence of the water, such that less than 50 ppb of oligomer residue is extractable from the cured film when immersed and heated in 10 ml of a simulant liquid per square inch of the cured film.